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(54) **Word length selectable memory.**

(57) An integrated circuit ROM comprises a memory cell matrix having a plurality of pairs of output lines, and plurality of pairs of external terminals. An output selection circuit is connected between the output lines and the external terminals and adapted to connect the output lines to the corresponding external terminals in a first mode and to alternatively connect output lines of each output line group to one predetermined external terminal of the corresponding external terminal group in a second mode. A control circuit is connected to at least one given external terminal which is disconnected from the corresponding output line when the output selecting circuit is in the second mode. This control circuit is in response to an address signal from the given external terminal to control the output selection circuit so as to cause it to selectively connect one output line of each output line group to the above predetermined external terminal of the corresponding external terminal group. Further, a mode selection circuit is associated to the output selection circuit and has a circuit structure fixed by a selected code mask so as to put the output selection circuit in a predetermined one of

the first and second modes.

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ory designs. In addition, if the number of the external terminals contained in each external terminal group is suitably selected, various memory structures can be produced.

In one embodiment of the memory in accordance with the present invention, the output selection means includes pass-through transfer gate means connected between the above predetermined external terminal of each external terminal group and the corresponding one output line of the corresponding output line group, cross transfer gate means connected between the above predetermined external terminal of each external terminal group and at least one remaining output line of the same output line group, and isolation transfer gate means connected between at least one remaining external terminal of each external terminal group and the corresponding output line. With this structure, when the output selection means is in the first mode, the pass-through and isolation transfer gate means are put in an ON condition while the cross transfer gate means are put in an OFF condition. When the output section means is in the second mode, the isolation transfer gate means is put in an OFF condition and the pass-through and cross transfer gate means are alternatively put in an ON condition and in an OFF condition by the control means.

Further, the control means includes one input connected to the given external terminal and an output connected directly to one of the pass-through and cross transfer gate means and though an inverter to the other of the pass-through and cross transfer gate means. Specifically, the control means includes an OR gate connected at its one input to the given external terminal, and the mode selection means is connected at its output to the isolation transfer gate means and another input of the OR gate. In addition, the mode selection means has an input selectively and fixedly connected to one of the ground and a supply voltage in accordance with the selected code mask.

In one preferred embodiment, the memory cell matrix has $(j+1)$ address input lines and $2i$ output lines divided into i groups each including two output lines. In this case, if the output selection means is in the first mode, the memory has the memory structure of 2^{j+1} words of $2i$ bits. To the contrary, if the output selection means is in the second mode, the given external terminal is used as an additional address input and the memory has the memory structure of 2^{j+2} words of i bits.

In another preferred embodiment, the memory cell matrix has $(j+1)$ address input lines and $4i$ output lines divided into i groups each including four output lines, and the cross transfer gate means

includes first, second and third cross transfer gates connected at their one end to the predetermined external terminal of each external terminal group. The other ends of these cross transfer gates are connected to the remaining three output lines of the corresponding output line group, respectively. Further, the isolation transfer gate means has three isolation transfer gates between the remaining three output lines of each output line group and the corresponding external terminals, respectively, so that when the output selection means is in the second mode, all the isolation transfer gates are put in an OFF condition, and the pass-through transfer gate means and the first, second and third transfer gates are alternatively put in an ON condition by the control means.

In this embodiment, the mode selection means includes a first output connected to all the isolation transfer gates and a second output adapted to have the same logical level as that of the first output and connected to all the pass-through transfer gate means. The mode selection means also includes an input selectively and fixedly connected to one of the ground and a supply voltage in accordance with the selected code mask.

Further, the control means includes a decoder having two inputs connected to two given external terminals which are disconnected from the corresponding output lines when the output selection means is in the first mode. This decoder also has four outputs connected to the pass-through transfer gate means and the first, second and third cross transfer gates, respectively, so as to put one of these transfer gates in the ON condition. Further, the decoder is adapted to be activated by the mode selection means when the output selection means is in the second mode.

In the embodiment, if the output selection means is in the first mode, the memory has the memory structure of 2^{j+1} words of $4i$ bits. But, if the output selection means is in the second mode, the two given external terminals are used as additional address inputs and the memory has the memory structure of 2^{j+4} words of i bits.

The above and other objects, features and advantages of the present invention will be apparent from the following description of preferred embodiments of the invention with reference to the accompanying drawings.

Brief Description of the Drawings

Figure 1 is a block diagram of a conventional ROM;

Figure 2 is a block diagram of a first embodiment of the ROM in accordance with the

present invention:

Figure 3 is a circuit diagram of a portion of the output section of the ROM shown in Figure 2;

Figures 4 and 5 illustrates the memory structures which can be selected in the ROM shown in Figure 2;

Figure 6 is a table showing logical levels and signal conditions at various points in the circuit shown in Figure 3; and

Figure 7 is a diagram similar to Figure 3 but showing a second embodiment of the ROM in accordance with the present invention.

Description of the Preferred Embodiments

Referring to Figure 1, there is shown a conventional ROM which includes a memory cell matrix 6 having a plurality of parallel outputs, which are in turn connected through a Y-selector 5, a sense amplifier 4 and an output buffer 3 to a number of output or external terminals O_0, O_1, \dots, O_m . On the other hand, address inputs $A_0, A_1, \dots, A_{j-1}, A_j$ are connected to an address input buffer 9, whose outputs are connected to a X-decoder 7 and a Y-decoder 8. The X-decoder 7 is connected to the memory matrix 6 and the Y-decoder 8 is connected to the Y-selector.

With this arrangement, an address data is inputted into the address input buffer, the X-decoder 7 and the Y-decoder 8 cooperate to select memory cells to be read out. As a result, the data stored in the selected memory cells is read out through the Y-selector 5 and detected by the sense amplifier 4, whose outputs are further amplified by the output buffer 3 and outputted to the external terminals.

In the above mentioned conventional ROM, the change of the memory structure requires another layout of an integrated circuit, which is very expensive.

Turning to Figure 2, there is shown a first embodiment of the ROM constructed in accordance with the present invention. In Figure 2, elements similar to those shown in Figure 1 are given the same Reference numerals and explanation will be omitted. As seen from comparison between Figures 1 and 2, the ROM shown in Figure 2 comprises an output selection logical circuit 2 connected between the output lines of the output buffer 3 and output or external terminals $O_1, O_2, \dots, O_{i-1}, O_i, O_{i+1}, \dots, O_{2i-1}, O_{2i}/A_1$, which are divided into i pairs. Namely, the first pair consists of the external terminals O_1 and O_{i+1} , the second pair of O_2 and O_{i+2} , ... the $(i-1)$ th pair of O_{i-1} and O_{2i-1} , and the i th pair of O_i and O_{2i}/A_1 . The logical circuit 2 is associated with a mode selector 1.

As shown in more detail in Figure 3 which shows the output circuit portion including the final pair of external terminals O_i and O_{2i}/A_1 , the logical circuit 2 includes a pass-through transfer gates Q_1 connected between the first external terminal $O_i - (O_1, O_2, \dots, O_i)$ of each external terminal pair and the output of the corresponding buffer amplifier Q_3 . Also, an isolation transfer gate Q_2 is connected between the second external terminal $O_{2i}/A_1 - (O_{i+1}, O_{i+2}, \dots, O_{2i-1}, O_{2i}/A_1)$ of each external terminal pair and the output of the corresponding buffer amplifier Q_4 . Further, each first external terminal O_i is connected through a cross transfer gate Q_3 to the connection node between the isolation transfer gate Q_2 and the corresponding buffer amplifier Q_4 .

Furthermore, the second external terminal O_{2i}/A_1 of the final external terminal pair is connected to one input of a NOR gate Q_4 , whose output CO is connected directly to a gate electrode of each cross transfer gate Q_3 and also connected through an inverter Q_5 to a gate electrode of each pass-through gate Q_1 .

The mode selector 1 includes a switch adapted to be connected to either the ground or a positive supply voltage V_{cc} in accordance with a code mask used in the course of memory production. A fixed terminal of the switch is connected through two cascade-connected inverters Q_6 and Q_7 to a gate electrode of each isolation transfer gate Q_2 and another input of the NOR gate Q_4 .

With this construction, if the mode selector 1 is connected to V_{cc} , the output signal Bm of the inverter Q_7 is at a high level, so that the output signal CO of the NOR gate Q_4 is maintained at a low level irrespectively of the signal level of the external terminal O_{2i}/A_1 . Thus, the pass-through transfer gate Q_1 and the isolation transfer gate Q_2 are fixed in an ON condition while the cross transfer gate Q_3 is fixed in an OFF condition. Therefore, the output signals a_2 and a_1 of the buffer amplifiers Q_3 and Q_4 are outputted to the external terminals O_i and O_{2i}/A_1 , respectively. Namely, all the external terminals are used as data outputs, and the circuit shown in Figure 3 acts as two-bit memory output.

On the other hand, if the mode selector 1 is connected to the ground, the output Bm of the inverter Q_7 is at a low level. Therefore, the isolation transfer gate Q_2 is fixed in the OFF condition, so that the external terminal O_{2i}/A_1 is isolated from the output a_1 of the buffer amplifier Q_4 . On the other hand, the output CO of the NOR gate Q_4 is determined by the logical level of the external terminal O_{2i}/A_1 . Therefore, in this case, the terminal O_{2i}/A_1 can be used as an additional address input. If the terminal O_{2i}/A_1 is at a high level, the gate Q_1 is put in an ON condition while the gate Q_2

connected through three cross transfer gates Q_{21} , Q_{22} and Q_{23} to the outputs of the buffer amplifiers 3 which are connected to the transfer gates Q_{31} , Q_{32} and Q_{33} .

5 With the above arrangement, the mode selector 1 is connected through two cascade-connected inverters Q_8 , and Q_9 to the gate electrodes of all the isolation transfer gates Q_{31} , Q_{32} and Q_{33} . The output of the inverter Q_9 is connected through an inverter 82 and an OR gate Q_4 , to the gate electrode of the pass-through transfer gate Q_1 . The external terminals Q_3/A_{-1} and Q_4/A_{-2} are connected to a decoder which includes four AND gates Q_{11} , Q_{12} , Q_{13} and Q_{14} and two inverters Q_{15} and Q_{16} connected as shown in Figure 7 for decoding a binary data of two bits. The AND gate Q_{11} is a two-input AND gate whose output is connected to another input of the OR gate Q_4 . The AND gates Q_{12} , Q_{13} and Q_{14} are three-input AND gates, each of which has its one input connected to the output of the inverter Q_9 . The AND gates Q_{12} , Q_{13} and Q_{14} are connected at their outputs to the gate electrodes of the cross transfer gates Q_{21} , Q_{22} and Q_{23} , respectively. The terminal Q_3/A_{-1} is connected directly to the AND gates Q_{11} and Q_{13} and also through the inverter Q_{15} to the AND gates Q_{12} and Q_{14} . The terminal Q_4/A_{-2} is connected directly to the AND gates Q_{11} and Q_{14} and through the inverter Q_{16} to the AND gates Q_{12} and Q_{13} .

With this construction, if the mode selector 1 is connected to Vcc, the output signal of the inverters Q_{a1} and Q_{a2} is at a high level, so that the output signal of the OR gate Q_{a1} is maintained at a low level irrespectively of the signal level of the external terminals Q_{31}/A_1 and Q_{41}/A_2 . Thus, the pass-through transfer gate Q_1 and the isolation transfer gates Q_{31} , Q_{32} and Q_{33} are fixed in an ON condition. On the other hand, since the output of the inverter Q_9 is low, the outputs of the AND gates Q_{a1} , Q_{a2} and Q_{a3} are fixed at a low level, so that the cross transfer gates Q_{21} , Q_{22} and Q_{23} are fixed in an OFF condition. Therefore, the output signals of the buffer amplifiers 3 are outputted to the external terminals O_{i1} , O_{21} , O_{31}/A_1 and O_{41}/A_2 , respectively. Namely, all the external terminals are used as data outputs. Therefore, the ROM has the address inputs $A_0 \dots A_j$ and the output bits $O_1 \dots O_{41}/A_2$, i.e., the memory structure of 2^{j+1} words of $4+j$ bits.

On the other hand, if the mode selector 1 is
50 connected to the ground, the output of the inverter
 Q_{11} is at a low level. Therefore, the isolation transfer
gates Q_{31} , Q_{32} and Q_{33} are fixed in the OFF con-
dition, so that the external terminals O_{21} , O_{31}/A_1 and
 O_{41}/A_2 are isolated from the outputs of the asso-
55 ciated buffer amplifiers. On the other hand, the
conditions of the transfer gates Q_{11} , Q_{21} , Q_{22} and Q_{23}

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are determined by the logical levels of the terminals O_{3i}/A_1 and O_{4i}/A_2 . Therefore, these external terminals are used as additional address inputs. With the terminals O_{3i}/A_1 and O_{4i}/A_2 of "1, 1", the transfer gate Q_i is ON, and Q_{2i} , Q_{2i} and Q_{2i} are OFF. With the combination of "0, 0", the transfer gate Q_i is ON, and Q_{1i} , Q_{2i} and Q_{2i} are OFF. With "1, 0", Q_{2i} is ON, and Q_{1i} , Q_{2i} and Q_{2i} are OFF. Further, with "0, 1", Q_{2i} is ON and Q_{1i} , Q_{2i} and Q_{2i} are OFF. Therefore, the ROM has the address inputs A_2 , A_1 , $A_0 \dots A_j$ and the output bits $O_1 \dots O_i$, i.e., the memory structure of 2^{j+4} words of i bits.

The invention has thus been shown and described with reference to specific embodiments. However, it should be noted that the invention is in no way limited to the details of the illustrated structures but changes and modifications may be made within the scope of the appended claims.

Claims

1. An integrated circuit memory comprising a memory cell matrix having a plurality of groups of output lines each group including at least two output lines; a plurality of groups of external terminals each group including at least two external terminals; output selection means connected between the output lines and the external terminals and adapted to connect the output lines to the corresponding external terminals in a first mode and to alternatively connect output lines of each output line group to one predetermined external terminal of the corresponding external terminal group in a second mode; control means connected to at least one given external terminal which is disconnected from the corresponding output line when the output selecting means is in the second mode, the control means being in response to a signal from the given external terminal to control the output selection means so as to cause it to selectively connect one output line of each output line group to the above predetermined external terminal of the corresponding external terminal group; and mode selection means associated to the output selection means and having a circuit structure fixed by a selected code mask so as to put the output selection means in a predetermined one of the first and second modes.

2. A memory as claimed in Claim 1 wherein the output selection means includes pass-through transfer gate means connected between the above predetermined external terminal of each external terminal group and the corresponding one output line of the corresponding output line group, cross transfer gate means connected between the above predetermined external terminal of each external

terminal group and at least one remaining output line of the same output line group, and isolation transfer gate means connected between at least one remaining external terminal of each external terminal group and the corresponding output line, so that when the output selection means is in the first mode, the pass-through and isolation transfer gate means are put in an ON condition while the cross transfer gate means are put in an OFF condition, and when the output selection means is in the second mode, the isolation transfer gate means is put in an OFF condition and the pass-through and cross transfer gate means are alternatively put in an ON condition and in an OFF condition by the control means.

3. A memory as claimed in Claim 2 wherein the control means includes one input connected to the given external terminal and an output connected directly to one of the pass-through and cross transfer gate means and through an inverter to the other of the pass-through and cross transfer gate means.

4. A memory as claimed in Claim 3 wherein the control means includes an OR gate connected at its one input to the given external terminal and wherein the mode selection means is connected at its output to the isolation transfer gate means and another input of the OR gate, the mode selection means having an input selectively and fixedly connected to one of the ground and a supply voltage in accordance with the selected code mask.

5. A memory as claimed in Claim 4 wherein the mode selection means includes two cascade-connected inverters.

6. A memory as claimed in Claim 2 wherein the memory cell matrix has $(j+1)$ address input lines and $2i$ output lines divided into i groups each including two output lines, and wherein the output selection means is in the first mode so that the memory has the memory structure of 2^{j+1} words of $2i$ bits.

7. A memory as claimed in Claim 2 wherein the memory cell matrix has $(j+1)$ address input lines and $2i$ output lines divided into i groups each including two output lines, and wherein the output selection means is in the second mode so that the given external terminal is used as an additional address input and the memory has the memory structure of 2^{j+2} words of i bits.

8. A memory as claimed in Claim 2 wherein the memory cell matrix has $(j+1)$ address input lines and $4i$ output lines divided into i groups each including four output lines, wherein the cross transfer gate means includes first, second and third cross transfer gates connected at their one end to the predetermined external terminal of each external terminal group, the other ends of these cross

transfer gates being connected to the remaining three output lines of the corresponding output line group, respectively, and wherein the isolation transfer gate means includes three isolation transfer gates between the remaining three output lines of each output line group and the corresponding external terminals, respectively, so that when the output selection means is in the second mode, all the isolation transfer gates are put in an OFF condition, and the pass-through transfer gate means and the first, second and third transfer gates are alternatively put in an ON condition by the control means.

9. A memory as claimed in Claim 8 wherein the mode selection means includes a first output connected to all the isolation transfer gates and a second output adapted to have the same logical level as that of the first output and connected to all the pass-through transfer gate means, the mode selection means also including an input selectively and fixedly connected to one of the ground and a supply voltage in accordance with the selected code mask.

10. A memory as claimed in Claim 9 wherein the control means includes a decoder having two inputs connected to two given external terminals which are disconnected from the corresponding output lines when the output selection means is in the first mode, the decoder having four outputs connected to the pass-through transfer gate means and the first, second and third cross transfer gates, respectively, so as to put one of these transfer gates in the ON condition, the decoder being adapted to be activated by the mode selection means when the output selection means is in the second mode.

11. A memory as claimed in Claim 8 wherein the output selection means is in the first mode so that the memory has the memory structure of 2^{i+1} words of $4i$ bits.

12. A memory as claimed in Claim 8 wherein the output selection means is in the second mode so that the two given external terminals are used as additional address inputs and the memory has the memory structure of 2^{i+4} words of i bits.

13. An integrated circuit memory comprising a memory cell matrix having at least first and second output lines; at least first and second external terminals; output selection means connected between the output lines and the external terminals and adapted to connect the first and second output lines to the corresponding first and second external terminals in a first mode and to alternatively connect the first and second output lines to the first external terminal in a second mode; control means connected to the second external terminal and in

response to a signal from the second external terminal when the output selecting means is in the second mode, to control the output selection means so as to cause it to selectively connect one of the output lines to the first external terminal; and mode selection means associated to the output selection means and having a circuit structure fixed by a selected code mask so as to put the output selection means in a predetermined one of the first and second modes.

14. A memory as claimed in Claim 13 wherein the output selection means includes pass-through transfer gate means connected between the first external terminal and the corresponding first output line, cross transfer gate means connected between the first external terminal and the second output line, and isolation transfer gate means connected between the second external terminal and the corresponding second output line, so that when the output selection means is in the first mode, the pass-through and isolation transfer gate means are put in an ON condition while the cross transfer gate means are put in an OFF condition, and when the output section means is in the second mode, the isolation transfer gate means is put in an OFF condition and the pass-through and cross transfer gate means are alternatively put in an ON condition and in an OFF condition by the control means.

15. A memory as claimed in Claim 14 wherein the control means includes one input connected to the second external terminal and an output connected directly to one of the pass-through and cross transfer gate means and though an inverter to the other of the pass-through and cross transfer gate means.

16. A memory as claimed in Claim 15 wherein the control means includes an OR gate connected at its one input to the second external terminal and wherein the mode selection means is connected at its output to the isolation transfer gate means and another input of the OR gate, the mode selection means having an input selectively and fixedly connected to one of the ground and a supply voltage in accordance with the selected code mask.

17. A memory as claimed in Claim 14 wherein the memory cell matrix has at least four output lines and the memory has at least four external terminals, wherein the pass-through transfer gate means is between the first external terminal of the four external terminals and the first output line of the four output lines, wherein the cross transfer gate means includes first, second and third cross transfer gates connected at their one end to the first external terminal, the other ends of these cross transfer gates being connected to the remaining three output lines, respectively, and wherein the isolation transfer gate means includes three isola-

tion transfer gates between the remaining three output lines and the corresponding external terminals, respectively, so that when the output selection means is in the second mode, all the isolation transfer gates are put in an OFF condition, and the pass-through transfer gate means and the first, second and third transfer gates are alternatively put in an ON condition by the control means.

18. A memory as claimed in Claim 17 wherein the mode selection means includes a first output connected to all the isolation transfer gates and a second output adapted to have the same logical level as that of the first output and connected to all the pass-through transfer gate means, the mode selection means also including an input selectively and fixedly connected to one of the ground and a

supply voltage in accordance with the selected code mask.

19. A memory as claimed in Claim 18 wherein the control means includes a decoder having two inputs connected to two given external terminals which are disconnected from the corresponding output lines when the output selection means is in the first mode, the decoder having four outputs connected to the pass-through transfer gate means and the first, second and third cross transfer gates, respectively, so as to put one of these transfer gates in the ON condition, the decoder being adapted to be activated by the mode selection means when the output selection means is in the second mode.

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FIGURE 1

PRIOR ART

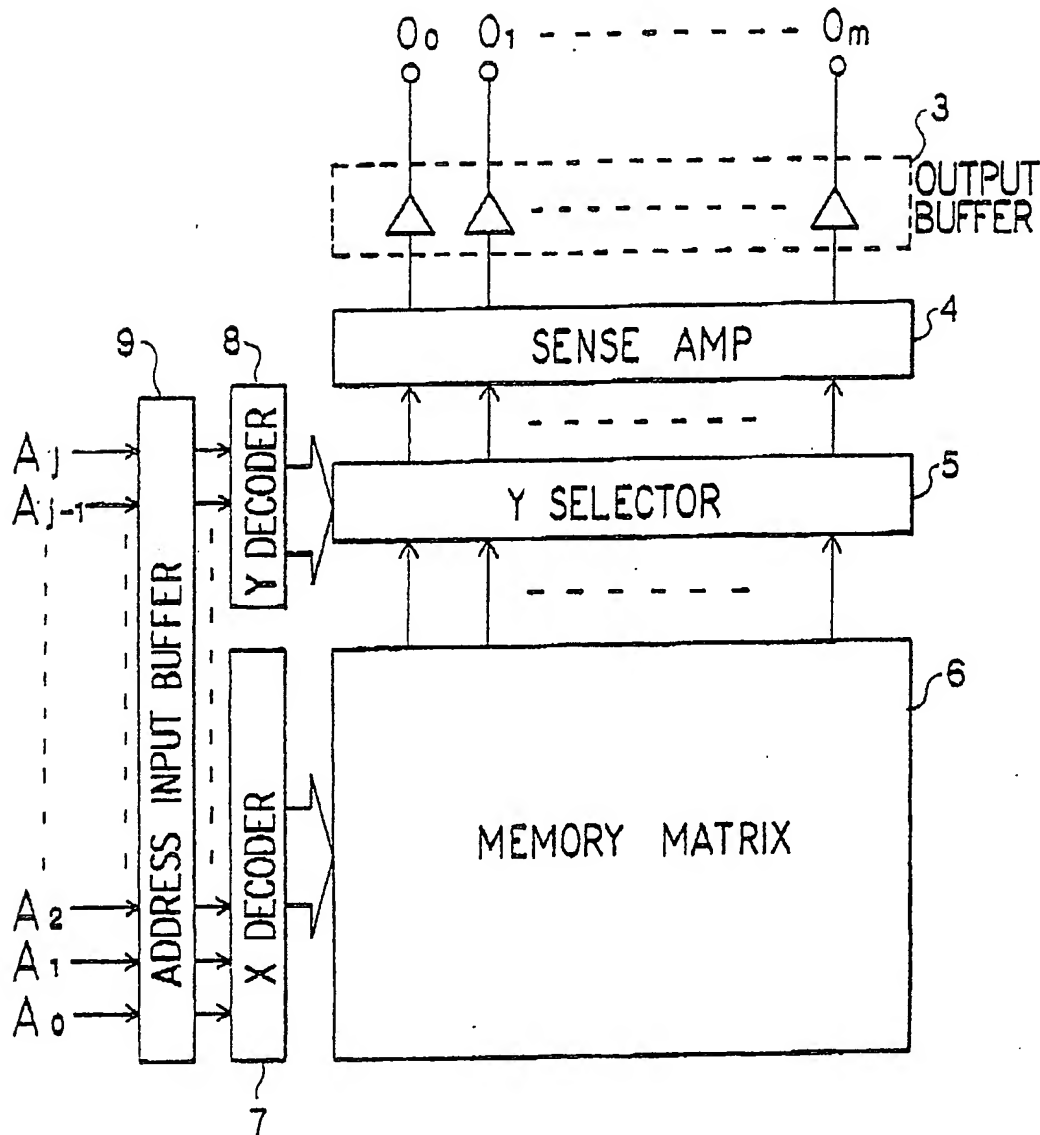


FIGURE 2

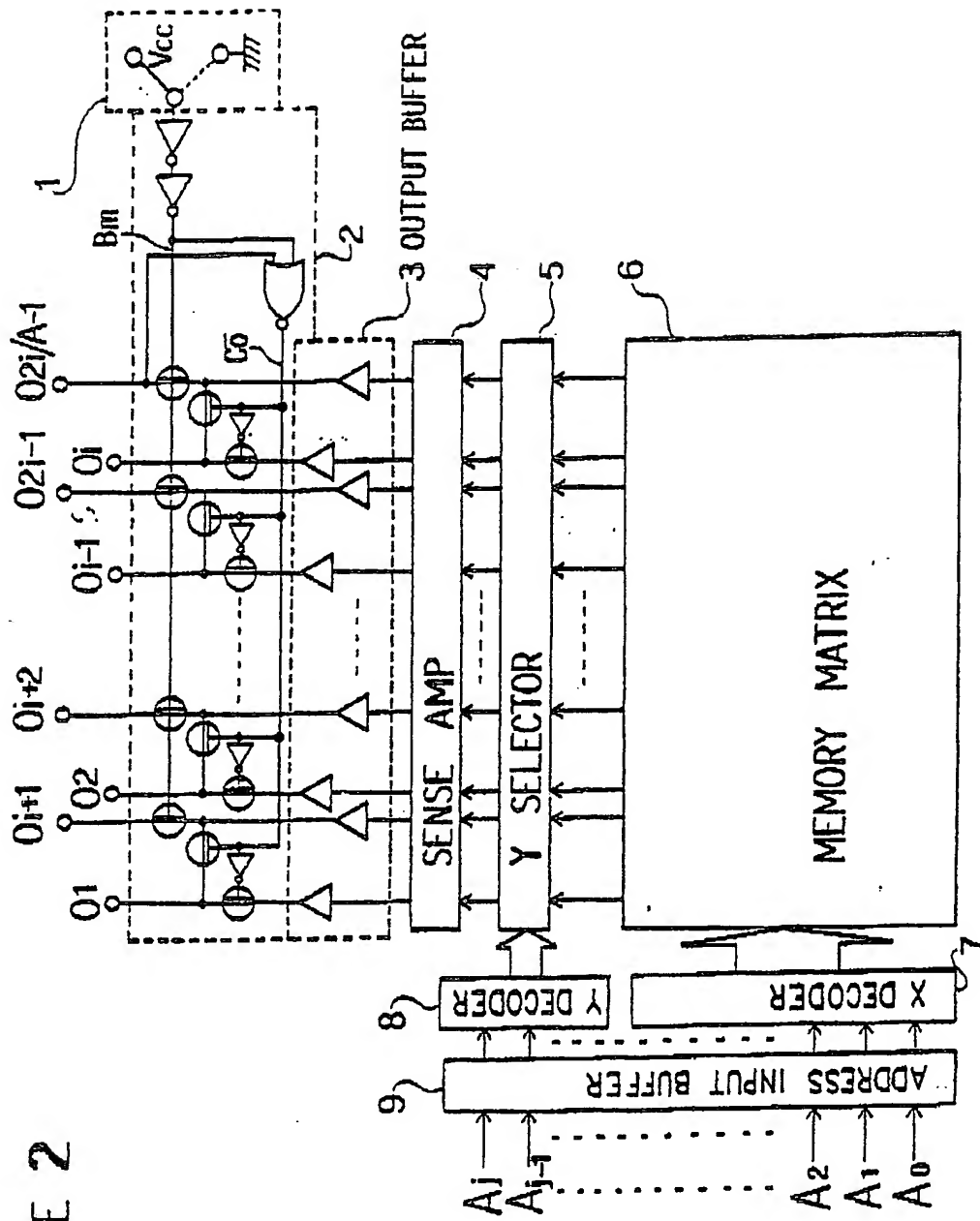


FIGURE 3

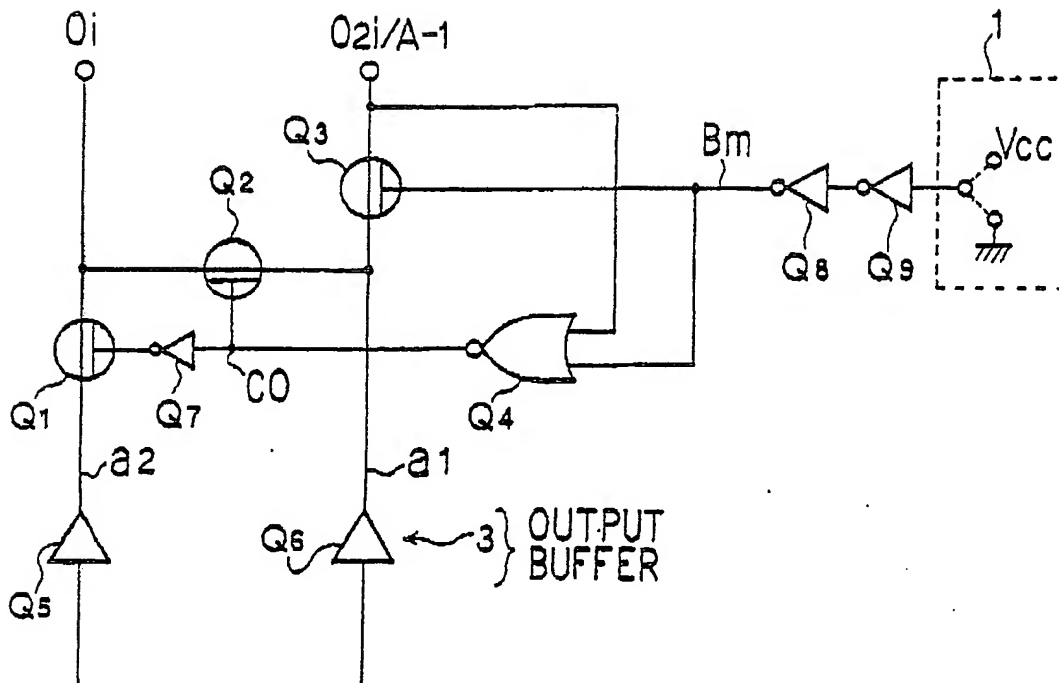


FIGURE 4

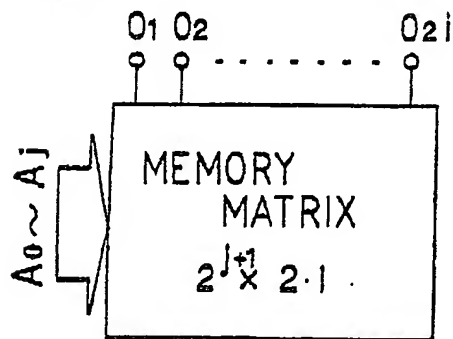


FIGURE 5

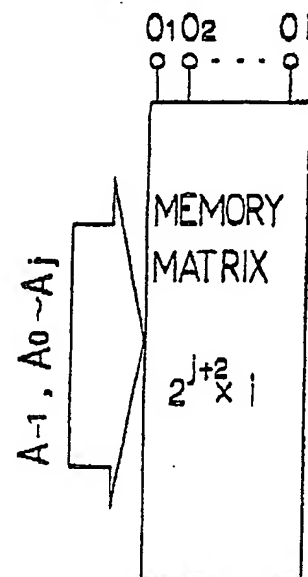
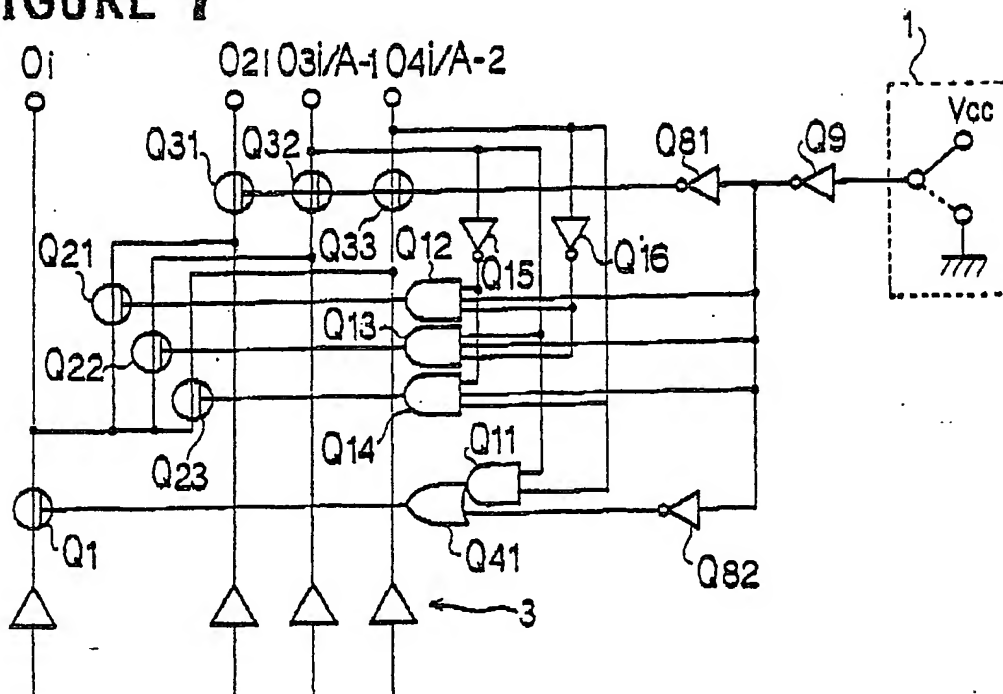


FIGURE 6

TERMINALS	BIT STRUCTURE	OUTPUT 1 BIT	OUTPUT 2 BIT	
	Bm	H	L	
	O _{2i/A-1}	—	L	H
	CO	L	H	L
	O _{2i/A-1}	a ₁	HI-Z	
	O _i	a ₂	a ₁	a ₂

FIGURE 7



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(54) Word length selectable memory.

(57) An integrated circuit ROM comprises a memory cell matrix having a plurality of pairs of output lines, and plurality of pairs of external terminals. An output selection circuit is connected between the output lines and the external terminals and adapted to connect the output lines to the corresponding external terminals in a first mode and to alternatively connect output lines of each output line group to one predetermined external terminal of the corresponding external terminal group in a second mode. A control circuit is connected to at least one given external terminal which is disconnected from the corresponding output line when the output selecting circuit is in the second mode. This control circuit is in response to an address signal from the given external terminal to control the output selection circuit so as to cause it to selectively connect one output line of each output line group to the above predetermined external terminal of the corresponding external terminal group. Further, a mode selection circuit is associated to the output selection circuit and has a circuit structure fixed by a selected code mask so as to put the output selection circuit in a predetermined one of

the first and second modes.

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European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 86 10 4924

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	PATENT ABSTRACTS OF JAPAN, vol. 7, no. 150 (P-207)[1295], 30th June 1983; & JP-A-58 60 480 (NIPPON DENSHIN DENWA KOSHA) 09-04-1983 * Abstract *	1,13	G 11 C 7/00
Y	EP-A-0 018 843 (FUJITSU) * Abstract; page 4, line 30 - page 5, line 1; figures 2,3 *	1,13	
A		2,4,9, 10,14, 16-18	
Y	PATENT ABSTRACTS OF JAPAN, vol. 3, no. 149 (E-157), 8th December 1979, page 57 E 157; & JP-A-54 128 226 (HITACHI SEISAKUSHO K.K.) 04-10-1979 * Abstract *	1,13	
Y	EDN ELECTRICAL DESIGN NEWS, vol. 23, no. 17, 20th September 1978, pages 89-93, Denver, US; C.A. OGDIN: "Reconfigurable memory scheme suits 8- or 16-bit words" * Page 92, column 1, line 8 - column 2, line 2; figure 5 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.4) G 11 C 5 G 11 C 7 G 11 C 11 G 11 C 17
A	PATENT ABSTRACTS OF JAPAN, vol. 2, no. 94, 5th August 1978, page 4403 E 78; & JP-A-53 57 932 (HITACHI SEISAKUSHO K.K.) 25-05-1978	1,2,13, 14	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13-06-1988	Examiner HARMS
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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